Coastal Geomorphology

Physical Oceanographic Processes.

Background.

Coastal wetlands and beaches in Cape Cod National Seashore are chronically polluted with waste from nearby urban and industrial centers, as well as from shipping lanes in the turbulent North Atlantic. Fairly small oil spills (less than 1000 liters) in the recent past at Coast Guard Beach and Hatches Harbor have clearly demonstrated the vulnerability of CACO resources, and the characteristics of beach litter, especially on bayside shores, have graphically illustrated CACO's sensitivity as a receptor for waste from metropolitan Boston. Regardless of the source or identity of the pollutants, their transport to outer Cape shores is dependent on the physics of the circulation of coastal waters, in turn controlled by short- and long-term geomorphology and local and regional weather. Seasonal changes in physical oceanographic processes likely also influence shoreline retreat and accretion, local fish populations and nutrient transport in the waters off Cape Cod, but CACO staff currently have no comprehensive source of information for physical oceanographic data affecting the outer Cape. Much of the data probably exists in different sources, and needs to be integrated into a coherent predictive tool to aid CACO managers in evaluating various on- and offshore developments and shipping proposals, and in forecasting the landfall of wastes for rapid and efficient cleanup and mitigation.

Research Needs.

Various sources of physical oceanographic data regarding transport to CACO waters and wetlands, and their relationship to shoreline change, local fish populations, nutrient input and contaminant movement in CACO waters, need to be investigated in order to better understand seasonal changes in physical oceanographic processes on Cape Cod. Existing data and models should be integrated into a system that provides CACO with the ability to pair season and approximate weather conditions to circulation patterns. If possible, such a program would be best incorporated into the evolving CACO Geographic Information System. Once developed, the predictive system would require regular updates to improve accuracy and technological precision and to accommodate observed changes in bathymetry and atmospheric forcing.

Related Research.

FitzGerald, D.M. and D.R. Levin. Hydraulics, morphology and sediment transport patterns at Pamet River Inlet: Truro, Massachusetts. Northeastern Geology. 1981; 3(3/4): 216-224.

Shoreline Retreat and Accretion.

Background.

Coastal erosion processes form the basis for a number of important natural and cultural resource management issues within Cape Cod National Seashore. Without erosion, the dunes and beaches so characteristic of Cape Cod would simply not exist; the Cape's wide beaches are borne of sand that erodes from the glacial cliffs along its shoreline, and just as some areas are retreating, others are growing with sand transported by wind and waves to their shores. All of the Province Lands, as well as Nauset Spit and much of Great Island, were created by the movement and relocation of sand as part of this process, and both Provincetown and Monomoy Island are still growing by about one acre a year with sand eroded from the outer Cape beaches. Although this dynamic process benefits coastal ecosystems, it can also complicate natural resource management in areas, like CACO, that are severely impacted by human activity. Shoreline configuration, shaped by erosion, determines the access routes and available corridor for public off-road vehicle (ORV) use in the seashore, and in the past has been responsible for re-routing ORV traffic closer to nests of the federally threatened piping plover (*Charadrius melodus*). Erosion can also cause severe damage to manmade structures that are built on top of the changing shoreline. The Highland and Nauset Lighthouses were recently moved inland to prevent them from falling into the sea, the Great Storm of 1978 completely demolished a 300-car parking lot located at Coast Guard Beach, and more recently, several private homes on a town-owned beach in Chatham were lost to the ocean as a result of shoreline retreat.

The areas that comprise the seashore have been continuously inhabited by European settlers since the mid-1600s, with historical impacts that include deforestation, nutrient-depleting agricultural practices, human-caused wildfire and sand mining. The migrating sand dunes in Provincetown are partly the result of human deforestation dating back to the seventeenth century, exacerbated in modern times by frequently used pedestrian social trails through the dunes. Although allowing natural shoreline processes to take place unimpeded is a primary management objective at CACO, justification for efforts to combat erosion in selected areas, primarily through planting beach grass (*Ammophila breviligulata*), is based on the premise that human activities initiated dune migration and continue to greatly accelerate the natural rate of erosion.

Shoreline Retreat and Accretion, continued.

Research Needs.

A geomorphic shoreline change monitoring program is currently being developed in partnership with the United States Geological Survey. Upon its completion, both immediate and long-term implementation of this plan will be needed to track and plan for geological changes to the outer Cape's coastline. Geomorphology monitoring plots established in the 1800s and 1970s should be identified and re-surveyed, when possible, to detect changes over time. Additional plots should also be established as needed, including areas on the Gut at Great Island in Wellfleet, and a sea level rise monitoring station should be set up to detect the long-term effects of global climate change on CACO's coastline. Once significant data have been acquired, CACO's Geographic Information System should be used to model future shoreline retreat, nearshore sand movement and dune migration. Although shoreline changes may be extrapolated from aerial photography, it is expected that the bulk of this research will be conducted through ground surveys, which are considered more effective.

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